WHC-MR-0227

Tank Wastes Discharged Directly to the Soil at the Hanford Site

J. L. Waite

Date Published
April 1991

Prepared for the U.S. Department of Energy
Office of Environmental Restoration
and Waste Management

Westinghouse Hanford Company
P.O. Box 1970
Richland, Washington 99352

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

THIS PAGE INTENTIONALLY
LEFT BLANK

Tank Wastes Discharged Directly to the Soil at the Hanford Site

Prepared for the U.S. Department of Energy
Office of Environmental Restoration
and Waste Management

Westinghouse
Hanford Company Richland, Washington

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

Approved for Public Release

THIS PAGE INTENTIONALLY
LEFT BLANK

THIS PAGE INTENTIONALLY
LEFT BLANK

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

This page intentionally left blank.

1.0 INTRODUCTION

The Hanford Site was established in 1943 to produce plutonium for nuclear weapons in support of World War II. Plutonium production continued after the war until January 1987 when the last production reactor ceased operation at the Hanford Site. Nine production reactors and five reprocessing facilities operated at the Hanford Site to support that mission. These operations created a large quantity of radioactive wastes, much of which was and continues to be stored in underground storage tanks.

The U.S. Department of Energy (DOE) currently operates the site for the U.S. Government. Actions discussed in this report were carried out by two of the DOE predecessor agencies: the Manhattan Engineer District of the U.S. Army Corps of Engineers and the Atomic Energy Commission (AEC). Contractors supported the government agencies in site management.

This report summarizes the type, quantity, and characteristics of wastes associated with the single-shell storage tanks discharged intentionally or inadvertently to the ground at the Hanford Site. This includes:

- Waste, discharged from the single-shell tanks (SST) directly to the ground via pumping or cascade overflow
- Leaks from SSTs
- Leaks from transfer lines and other unplanned releases and spills.

The report does not address process condensate wastestreams resulting from the evaporator concentration or other processing of tank wastes. These condensate streams were of much larger volume, but contained significantly less radionuclide content. These streams are documented in other reports. This report does not address the many other liquid disposal sites that received other (non-SST) wastes as part of the soil column disposal practices at the Hanford Site.

Section 2.0 summarizes the content of this report. Section 3.0 describes the process steps and the tank wastestreams that were subsequently discharged to the ground. Section 4.0 provides a brief discussion of the chemicals in the tank wastes discharged to the ground. Section 5.0 discusses ongoing activities and future plans to address the environmental impact and cleanup of these and other waste discharges to the ground at the Hanford Site.

This report expresses curie levels at current rather than historical levels. Radionuclide values (in curies) are decayed to December 1989, which is consistent with the latest issue of the Effluent Discharges and Solid Waste Management Report for the 200/600 Areas of the Hanford Site (Brown et al. 1990). It should be noted that some of the wastes contained significantly higher radionuclide levels at time of discharge because of short-lived fission products. For example, the wastes discharged to the ground from the uranium recovery process (see Section 3.2) contained very high levels of ruthenium-106. Ruthenium-106 has a half-life of 373 days and has since

decayed to insignificant levels. Hanford Site workers had to take precautions during those periods of discharge to minimize exposure to the operating personnel.

Appendix A provides a glossary of key terms used in this report. A review of this appendix is recommended before reading this report. Appendices B through E provide specific information on individual disposal sites.

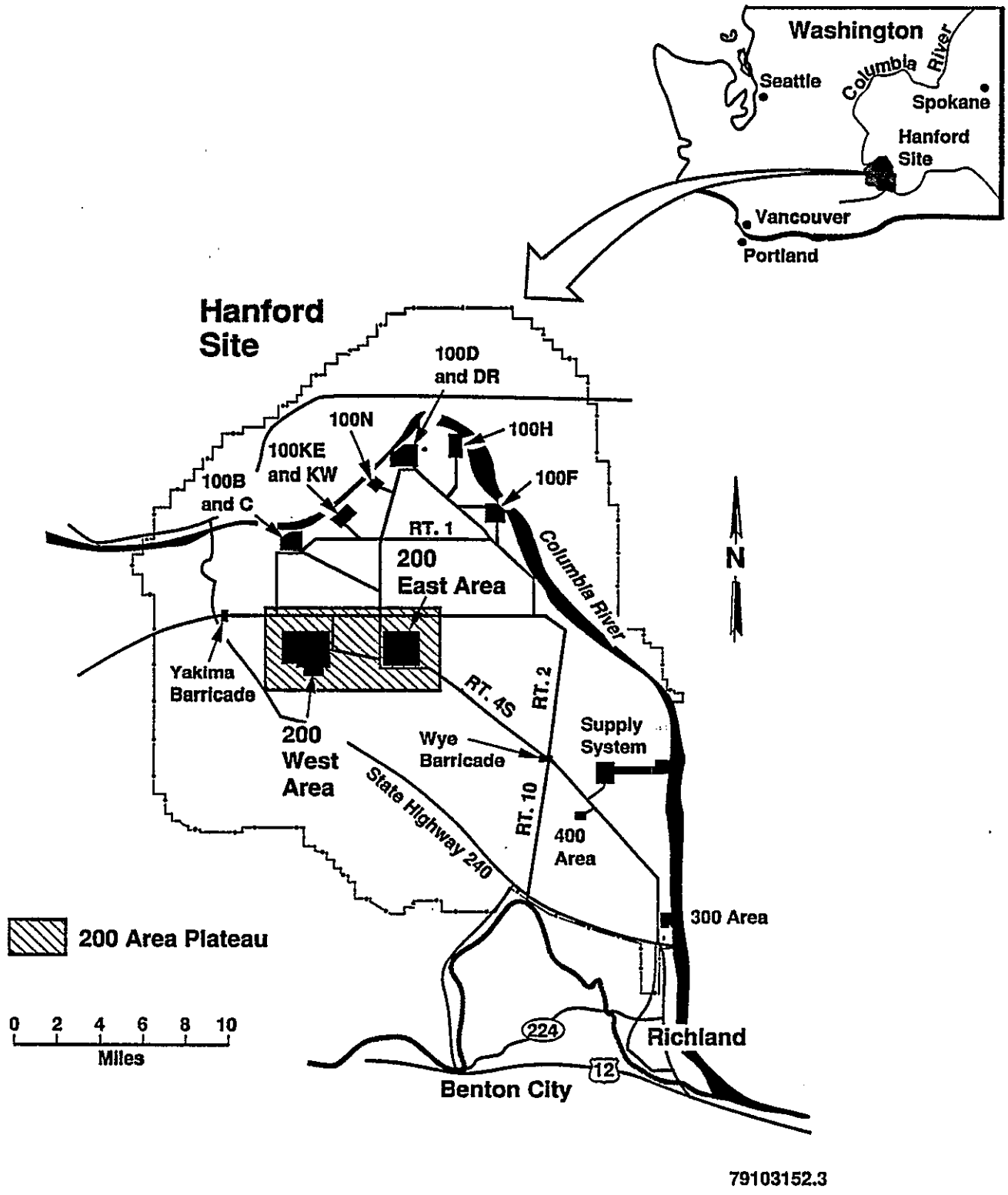
2.0 SUMMARY

Documents show that from 1946 to 1966, 456,725,000 liters (120,661,000 gallons) of liquid wastes were intentionally discharged from SSTs at the Hanford Site directly to the ground on the 200 Area plateau (Figure 1). The majority of this waste was discharged from 1946 to 1958 as a result of the early plutonium and uranium recovery processes conducted in the 221-B facility (B Plant)/the 221-T facility (T Plant) and the 221-U facility (U Plant), respectively. In addition, from 1960 to 1966 laboratory wastes from the 300 Area and equipment decontamination wastes from the 200 West Area were routed through SSTs before discharge to the ground. No wastes have been discharged intentionally to the ground from SSTs since 1966, and no wastes have ever been discharged directly to the ground from the newer double-shell tanks (DST) located at the Hanford Site.

In addition to the tank wastes intentionally discharged to the ground, tank wastes have been released to the ground as a result of leaks from SSTs and transfer lines, and other miscellaneous spills. Sixty-six SSTs are assumed to have leaked. The current estimate of the volume of waste leaked from SSTs is 2,839,000 liters (750,000 gallons). This estimate does not include the leakage volume from the addition of cooling water sprayed into the 105-A tank. Hanford Site engineers are now making calculations to estimate what that added volume may have been. The *Tank Farm Surveillance and Waste Status Summary Report for November 1990* (Hanlon 1991) estimated an additional 189,000 to 3,028,000 liters (50,000 to 800,000 gallons) may have leaked from tank 105-A as a result of the cooling water addition. Hanford Site engineers also are studying records to find out if other tanks also received and lost cooling water.

Of approximately 300 unplanned releases and spills identified in the Waste Information Data System (WIDS), approximately 70 are associated with tank wastes. These are in addition to the 66 assumed leaking tanks noted above. It is estimated that a total of at least 378,000 liters (100,000 gallons) of liquid wastes were released to the ground as a result of these unplanned releases and spills. There is very little information on volume or characteristics of these unplanned releases and spills. Many indicate low levels of activity (e.g., less than 10 curies). One area where documents show significant levels of long-lived fission products being released inadvertently to the ground was C-Tank Farm in 1969 and 1971. One

Figure 1. Hanford Site Map.



unplanned release (UN-200-E-86) in March 1971, as documented in the WIDS, resulted in the release of an estimated 25,000 curies (at the time of discharge) of cesium-137 to the ground. This was a transfer line leak from the Plutonium-Uranium Extraction (PUREX) Plant to the tank farm.

Table 1 compares the volume and characteristics of tank wastes discharged intentionally or inadvertently to the ground with those now contained in the SSTs and DSTs. Most of the long-lived radionuclides still remain in the tanks even though the total volume of liquid discharged exceeds that which is now in the tanks. Since the tanks were constructed with carbon steel liners, all wastes sent to the tanks were neutralized before transfer. This precipitated the major fraction of the uranium, metals, transuranic wastes, and strontium-90 and significantly enhanced the settling process. The supernatant (liquid) was then cascaded or pumped from the top of the tanks, while the settled solids remained in the tanks. Some of the quantities in Table 1 are measured while others are estimates. The values for other leaks and spills are only for those that have documented values.

Even though most of the long-lived radionuclides remained in the tanks, waste discharges remain a concern. Because of the contamination levels and volume of liquids discharged, the groundwater has been contaminated beyond drinking water standards in some areas of the Hanford Site. These discharges also contaminated large amounts of soil. Of concern are not only the radionuclides, but chemicals discharged as part of the tank waste. Information on the chemical discharges is limited at this time. More information on both chemicals and radionuclides will have to be gathered through the appropriate regulatory investigation process to determine what actions are appropriate. These discharges have created some of the greatest cleanup challenges.

An investigation and cleanup program is under way to assess the environmental impact of these past discharges along with all other wastes disposed on the Hanford Site. In May of 1989 the DOE, the U.S. Environmental Protection Agency (EPA), and the Washington State Department of Ecology (Ecology) entered into the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1990). The Tri-Party Agreement provides for a regulated process to address the environmental impact and cleanup of the disposal sites this report covers.

3.0 INTENTIONAL TANK WASTE DISCHARGES

This section describes wastes that were discharged intentionally directly to the ground from SSTs at the Hanford Site. It was planned originally that some of these wastes would be discharged to the ground after they had settled for a period of time in tanks. It was planned to store other wastes for the long term in SSTs, but these wastes were discharged subsequently from the tanks to provide tank space necessary to continue supporting the production mission. Workers took steps to minimize the amount of radionuclides that entered the ground from these wastes.

Table 1. Comparison of Tank Wastes Discharged to Ground to Current Tank Inventories.

	Current tank inventories (as of Dec. 1989)	Intentional discharges[a]		Inadvertent releases[a]	
		Cribs	Specific retention trenches	Tank leaks	Other leaks and spills
Volume (thousands of gallons)	64,700	91,880	28,781	750[b]	>100
Key radionuclides (curies)					
Tritium	239,000[c]	930[c]	4,100[c]	e	e
Strontium-90[d]	69,500,000	8,992	4,189	e	>225
Cesium-137[d]	35,600,000	3,047	13,408	52,520	>23,420
Technetium-99	32,200	170[c]	760[c]	e	e
Iodine-129	50	0.6[c]	1.2[c]	e	e
Carbon-14	5,000	e	e	e	e
Uranium	500 (1,440,000 kg)	4.85[c] (5,044 kg)	4.67[c] (4,859 kg)	e	e
Americium-241	98,500	148	6	e	e
Plutonium	31,900 (445 kg)	528 (7.2 kg)	21 (0.3 kg)	e	e
Total Curies	208,700,000	25,694	39,362	102,000	>47,300

[a] Numbers reflect data in the database and were used so they could be traced. They reflect greater accuracy than warranted by the number of figures shown. Two or three significant figures would reflect data accuracy better.

[b] Does not include cooling water leakage from the 105A tank which is estimated from 50,000-800,000 gallons.

[c] Existing databases do not report inventory. Quantities were estimated based on fuel irradiation and process knowledge. Uranium, americium-241, and plutonium curies calculated based on documented kilogram values.

[d] Daughters are not included but are reflected in total curies. Daughters account for 103,431,850 curies in total current tank inventories, 11,874 curies in discharges to cribs, and 16,872 curies in discharges to specific retention trenches.

[e] Not available and cannot be estimated.

These wastes were discharged primarily to the ground during the 1940s and 1950s as part of the early plutonium and uranium recovery operations. Two types of disposal sites were used to discharge tank wastes to the ground from SSTs: cribs and specific retention trenches (see Appendix A). A total of 55 disposal sites received tank waste intentionally discharged to the ground. Only two of these sites received other types of waste after receiving tank waste. The 216-T-19 crib received significant quantities of process and steam condensate from the 242-T Evaporator through 1976. The 216-B-7 A and B cribs received a small amount of cleanout wastes from B Plant through 1967.

Tank waste discharge information is organized in this section according to the operations that resulted in the discharges. The appendices include specific information on the individual disposal sites. In Appendix B are maps of 200 East and 200 West Areas to show the general location of facilities and disposal sites. Appendix C has a table showing volumes, dates of operation, and waste types for each waste disposal site. Appendix D has more information about the radionuclides discharged at the disposal sites. Appendix E provides estimates of chemicals discharged at the disposal sites.

This section is divided into the following three categories of operation to explain the processes and methods by which wastes were discharged to the ground.

- Fuel reprocessing in B Plant and T Plant (1944-1956)
- Uranium recovery in U Plant (1952-1957)
- Equipment decontamination and 300 Area laboratory operations (1960-1966).

Table 2 summarizes the periods of time, volumes, and radionuclide contents for the wastes discharged from these operations.

3.1 FUEL REPROCESSING IN B PLANT AND T PLANT (1944-1956)

B Plant and T Plant were the initial fuel reprocessing plants used at the Hanford Site to separate plutonium from the fission products. These plants used the bismuth phosphate process to recover plutonium. This was the first of three plutonium recovery processes used at the Hanford Site. B Plant operated from April 1945 through October 1952, and T Plant operated from December 1944 through August 1956. Figure 2 is a flow diagram of the basic process steps and wastestreams this section discusses. These wastestreams were discharged from SSTs directly to the ground and are described below.

The first step in the process was to remove the metal cladding on the fuel. This resulted in the coating-removal waste that was subsequently combined with the first-cycle decontamination waste (discussed below) for storage in SSTs. The coating waste contained small amounts of fission products. Hereafter, reference is made only to the first-cycle wastestream, which also contained the coating waste.

Table 2. Tank Wastes Intentionally Discharged to the Ground from Single-Shell Tanks.[a]

Waste source	Years discharged	Total volume discharged in liters (gallons)	Total curies (decayed to December 1989)
Fuel reprocessing in B Plant and T Plant (1944-1956)	1946-1956	259,435,000 (68,540,000)	28,155
Uranium recovery in U Plant (1952-1957)	1953-1958	154,990,000 (40,946,000)	30,336
Equipment decontamination and 300 Area laboratory operations	1960-1966	42,300,000 (11,175,000)	594
TOTAL		456,725,000 (120,661,000)	59,085[b]

[a]Numbers reflect data in the database and were used so they could be traced. They reflect greater accuracy than warranted by the number of figures shown. Two or three significant figures would reflect data accuracy better.

[b]The total does not include tritium, technetium-99, or iodine-129 because existing databases do not include these data. Based on fuel irradiation and process knowledge, the estimated decayed quantities discharged to the ground for tritium, technetium-99, and iodine-129 are 5,030, 930, and 1.8 curies, respectively.

The next step in the process was to dissolve the uranium and extract the plutonium. This resulted in the metal wastestream. The metal wastestream contained the bulk of the uranium and approximately 90 percent of the long-lived fission products (e.g., cesium-137 and strontium-90) and was sent to underground SSTs for storage. This stream eventually became the source of uranium that was recovered as part of the uranium recovery process discussed in Section 3.2 of this report.

Once the plutonium had been extracted, it went through two decontamination cycles to purify it further. The first decontamination cycle wastestream contained almost 10 percent of the long-lived fission products and was sent to SSTs for storage. The second decontamination cycle wastestream, which contained less than 0.1 percent of the fission products, was sent to SSTs for storage until mid-1948. At that time, because of limited tank space, the AEC decided to discharge the second-cycle waste supernatant to the ground after it was cascaded through the SSTs. Therefore, the second-cycle waste supernatant was discharged to cribs and trenches from 1948 to the shutdown of T Plant in 1956. This included the second-cycle wastes that had been stored in the SSTs before 1948. The second-cycle wastes discharged to cribs were combined with two other wastestreams described below. These combined wastestreams accounted for more than 85 percent of the volume discharged to the ground from SSTs in support of the irradiated fuel recovery operations in B Plant and T Plant but less than 20 percent of the radionuclides. Table 3 provides a summary by years discharged, disposal sites, volume discharged, and radionuclide content for these and other wastestreams discharged to the ground from the B Plant and T Plant operations.

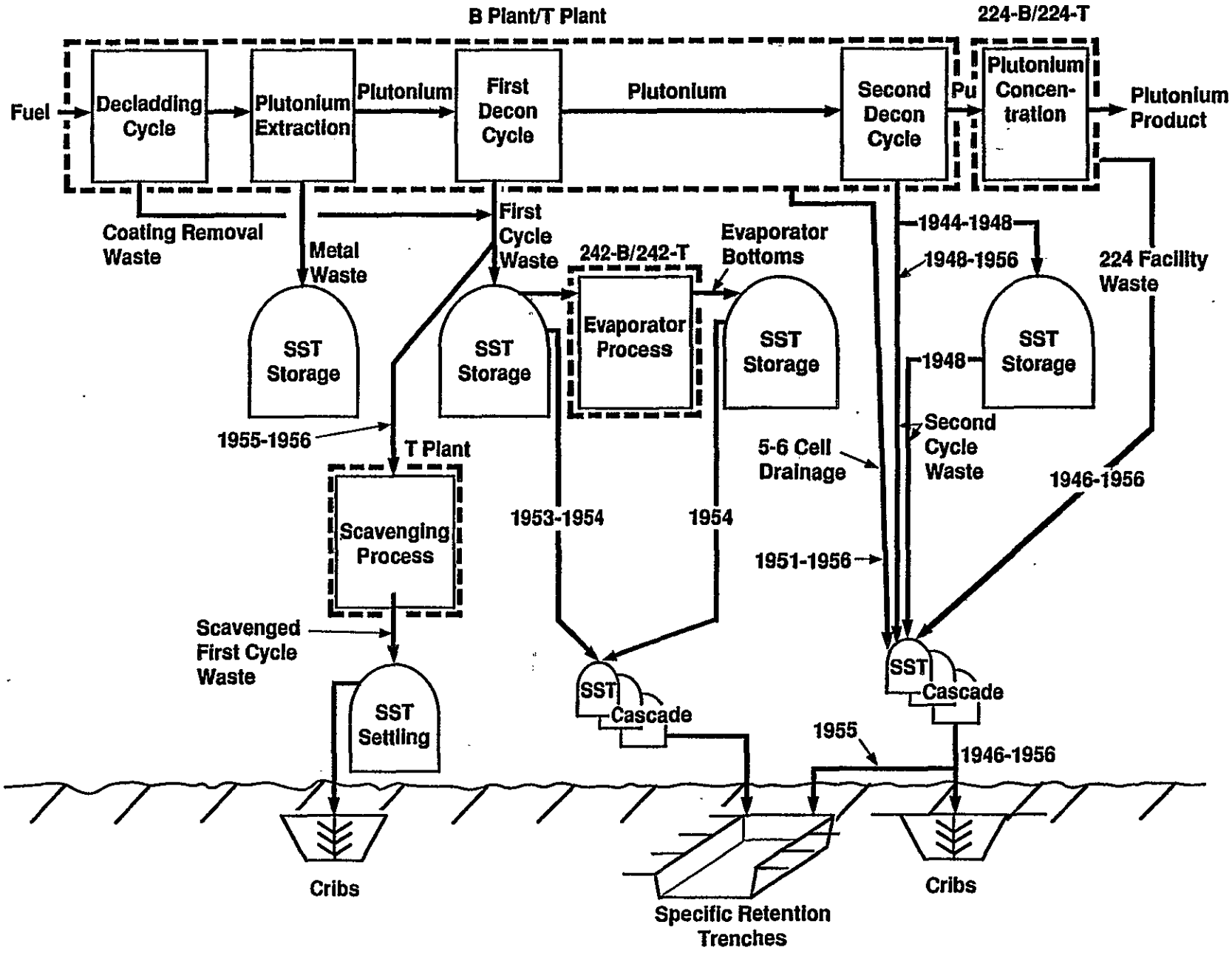


Figure 2. Fuel Reprocessing in B Plant and T Plant (1944-1956).

Table 3. Fuel Reprocessing Wastes Intentionally Discharged to the Ground from Single-Shell Tanks.[a]

	Years discharged	Disposal sites	Total volume discharged in liters (gallons)	Total curies (decayed to December 1989)
Second-cycle supernatant from B Plant and T Plant[b]	1948-1956	216-B-7A&B cribs 216-B-8 crib 216-T-5 trench 216-T-7 crib 216-T-19 crib 216-T-32 crib	222,280,000 (58,725,000)	5,618
Cell drainage from B Plant and T Plant[b]	1951-1956			
Plutonium concentration and decontamination from 224-T and 224-B facilities[b]	1946-1956			
First-cycle supernatant wastes from B Plant and T Plant	1953-1954	BX trenches (35, 36, 38-41) T trenches (14-17) TX trenches (21-24)	17,835,000 (4,711,000)	11,665
Evaporator bottoms from 242-T and 242-B evaporators	1954	216-B-37 trench 216-T-25 trench	7,320,000 (1,934,000)	10,155
Scavenged first-cycle supernatant from T Plant	1955-1956	216-T-26 crib	12,000,000 (3,170,000)	717
TOTAL			259,435,000 (68,540,000)	28,155[c]

[a] Numbers reflect data in the database and were used so they could be traced. They reflect greater accuracy than warranted by the number of figures shown. Two or three significant figures would reflect data accuracy better.

[b] Volume and radionuclide contents have been combined as wastes were sent to common disposal sites.

[c] Inventory does not include tritium, technetium-99, or iodine-129.

Cell drainage waste was collected from B Plant and T Plant operations, sent to in-plant tanks (the so called 5-6 cells) for interim storage, and then discharged to cribs. Starting in 1951 until the plants shut down, the cell drainage waste was routed along with the second-cycle wastes and 224 facility wastes (see below) through an SST cascade before discharging to cribs. This cell drainage waste never was intended to be stored permanently in the SSTs. Instead, the SSTs were used as settling tanks before discharging the waste to the ground. From startup of the plants until 1951, these wastes were settled within the plants and then discharged directly to the ground.

The 224-B and 224-T buildings are adjacent to B Plant and T Plant, respectively. These buildings were the original plutonium concentration facilities in the plutonium recovery process. Like the cell drainage discussed above, this waste was not intended to be stored in SSTs. Beginning in 1946 at 224-T building, and 1947 at 224-B building, the 224 facility wastes were routed to the 208,000-liter (55,000-gallon) SSTs for settling before being discharged to the cribs. These small SSTs are referred to as the 200-series tanks. The wastes were discharged from the 224-B building, including wastes from facility cleanout, until 1953. (B Plant ceased operation in 1952.) They continued to discharge wastes from the 224-T building until T Plant ceased operation in 1956.

The primary concern about the wastestreams from the 224 facilities was plutonium. The majority of the plutonium remained in the tanks after settling. Still, the wastes from these facilities was the primary contributor of plutonium to the ground from all of the tank waste discharges. From 1945 to 1947, these were settled in small, separate, underground settling tanks before being discharged to the ground.

To provide tank space needed to support continued production operations, first-cycle waste supernatant that had been stored in SSTs was discharged to specific retention trenches in 1953 and 1954. In 1954, evaporator bottoms (from the evaporation of the first-cycle wastes in the 242-B and 242-T evaporators) also were discharged to the ground and to specific retention trenches. The discharge of evaporator bottoms ceased after one campaign each was conducted in 200 East Area and 200 West Area. Almost 26 million liters (7 million gallons) of first-cycle waste and evaporator bottoms supernatant were discharged to the ground. This resulted in the largest discharge of radionuclides to the ground from the fuel reprocessing mission.

Beginning in 1955, the newly generated first-cycle waste in T Plant was scavenged before sending it to SSTs for settling and subsequent discharge to the ground. The scavenging involved adding chemicals to the waste to cause the normally soluble cesium-137 to precipitate in the settling process before discharge. The scavenging of the first-cycle waste significantly reduced the quantity of long-lived fission products discharged to the ground (see Table 3). A more in-depth discussion of the scavenging process is provided in Section 3.2.

3.2 URANIUM RECOVERY IN U PLANT (1952-1957)

U Plant was one of the three original fuels-separation facilities, along with B Plant and T Plant, but was never used for that purpose. Later it was converted to recover the uranium from the stored metal waste generated from the fuel reprocessed in B Plant and T Plant. Figure 3 depicts the process and wastestream flow for the uranium recovery process. From 1952 to late 1957 the metal waste was sluiced from the SSTs and pumped to U Plant to recover the uranium. The U Plant used the tributyl-phosphate-solvent extraction process to recover uranium. Initially, the resultant uranium recovery waste was returned to SSTs for storage.

While the tributyl-phosphate process efficiently recovered uranium from the sluiced, acidified metal waste, the process generated almost 2 liters of waste for every liter of metal waste processed. The 242-B and 242-T tank farm evaporators had already been put in operation to concentrate and, therefore, reduce the volume of waste stored in the SSTs. Even with this, the tank space was not sufficient to support the uranium recovery mission and to continue fuel reprocessing operations. The ferrocyanide scavenging process was developed to reduce the volume of wastes that had to be stored in SSTs.

The objective of the ferrocyanide scavenging process was to precipitate the soluble long-lived cesium-137 from the uranium recovery waste supernatant so it could be discharged to the ground. The metal waste contained approximately 90 percent of the long-lived fission products from the fuel reprocessing. It was important, in dealing with all wastestreams, to maintain the long-lived fission products in storage. The other principal long-lived fission product, strontium-90, was already essentially insoluble in the neutralized uranium recovery waste and precipitated without adding scavenging chemicals. During the latter years of the scavenging process, chemicals (calcium nitrate or strontium nitrate) were added to enhance the precipitation of the strontium-90.

The ferrocyanide scavenging process was tested in U Plant in October 1953, when ferrocyanide and nickel were added to the uranium recovery waste. The treated test waste was pumped [approximately 1,893,000 liters (500,000 gallons)] to an SST for settling. Because of poor pH control during the first half of the test, only half of the resultant scavenged waste supernatant was discharged to the 216-T-18 crib. The remainder remained stored in the SST.

Full-scale scavenging of the uranium recovery waste began in late September 1954. By this time, about 80.3 million liters (21.2 million gallons) of unscavenged uranium recovery waste were stored in the tank farms in both 200 East and 200 West Areas. From 1954 to June 1957, the newly generated uranium recovery waste was scavenged in U Plant and transferred to 200 East Area for settling in SSTs. Then it was discharged to the ground. The scavenged supernatant was sampled and analyzed to ensure it was within allowable limits (at the time) before it was discharged to the ground.

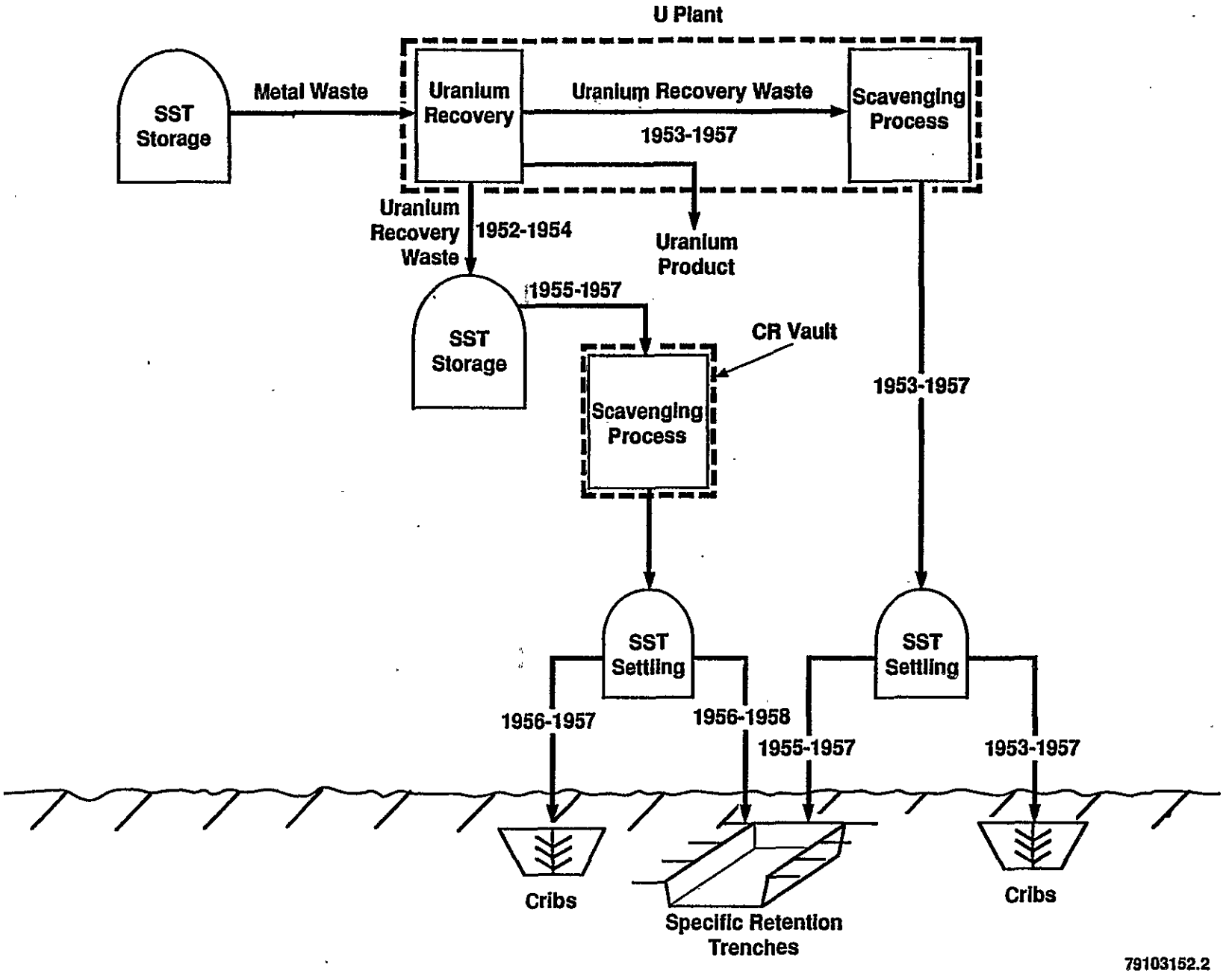


Figure 3. Uranium Recovery in U Plant (1952-1957).

Beginning in May 1955, wastes that were stored in 200 East Area from the earlier uranium recovery processing were also scavenged and discharged to the ground. The wastes were routed to the CR vault in 200 East Area tank farm where the wastes were scavenged. The waste then was routed back to SSTs for settling, and the supernatant subsequently was pumped to the ground. This was referred to as "in-tank farm" scavenging. The scavenging in the CR vault ended in December 1957. The last of these wastes were discharged to the ground in January 1958. The in-tank farm scavenged supernatant also was sampled and analyzed before it was discharged.

Of the total 154,990,000 liters (40,946,000 gallons) of scavenged uranium recovery waste discharged to the ground, approximately 44,290,000 liters (11,700,000 gallons) resulted from the in-tank farm scavenging of the waste stored in 200 East Area tanks. There also were plans to scavenge and discharge the unscavenged uranium recovery waste that was stored in 200 West Area. Preparations were made, but the waste was never scavenged, and it remained stored in the tanks.

The original plan called for discharging all of the scavenged supernatant into cribs. However, in 1956, it was found that cobalt-60 in the supernatant would go to the groundwater and exceed allowable AEC limits. Cesium-137 and eventually technetium-99 also have been detected in the groundwater as a result of these operations. It was decided then to dispose of the high cobalt-60 waste to the ground using specific retention trenches, to preclude the cobalt-60 and other radionuclides from reaching the groundwater. Soil conditions were measured and soil volumes calculated to determine the appropriate volume of liquid to be discharged. For further information and concerns on the use of specific retention trenches, see *A History and Discussion of Specific Retention Disposal of Radioactive Liquid Wastes in the 200 Areas* (Haney and Honstead 1958).

In 1954 and 1955, the scavenged uranium recovery waste supernatant was discharged initially to the BY cribs and to one of the BX trenches in the 200 East Area. From 1956 to early 1958, the supernatant was discharged to the BC cribs and specific retention trenches located south of the 200 East Area. Table 4 summarizes the volume and total curies discharged to the ground. Not reflected in the total curies is the 1,000,000 plus curies of short-lived ruthenium-106 discharged to the cribs and trenches, which has since decayed to insignificant levels. The Hanford Site workers took great care during the disposal operation to minimize exposure to operating personnel from the radiation given off from the ruthenium.

3.3 EQUIPMENT DECONTAMINATION AND LABORATORY WASTES (1960-1966)

Beginning in 1959, steam condensate, decontamination waste, and miscellaneous effluents were sent from T Plant to the SSTs for cascading and subsequent discharge to the 216-T-28 crib. Beginning in 1963, decontamination wastes from the 2706-T equipment decontamination facility were combined with the waste from T Plant. Starting in 1964, 300 Area laboratory wastes were shipped from the 340 waste transfer facility to the 200 West Area and combined

with the T Plant and 2706-T streams. The 2706-T stream was rerouted directly to a separate crib in 1964. The other streams continued to be discharged to the 216-T-28 crib via SSTs until 1966. A total of 42,300,000 liters (11,175,000 gallons) of waste was routed through SSTs to this crib, resulting in 594 curies of fission products (see Table 2). The 340 facility waste was rerouted directly to other cribs in 1966.

Table 4. Uranium Recovery Tank Wastes Intentionally Discharged to the Ground.[a]

Disposal site	Years discharged	Total volume discharged in liters (gallons)	Total curies (decayed to December 1989)
216-T-18 (test run)	1953	1,000,000 (264,000)	223
BY cribs (7 cribs)	1954-1955	33,840,000 (8,940,000)	14,270
216-B-42 (BX trench)	1955	1,500,000 (396,000)	1,010
BC cribs (6 cribs)	1956-1957	38,960,000 (10,293,000)	3,246
BC trenches (16 trenches)	1956-1958	79,690,000 (21,053,000)	11,587
TOTAL		154,990,000 (40,946,000)	30,336[b]

[a]Numbers reflect data in the database and were used so they could be traced. They reflect greater accuracy than warranted by the number of figures shown. Two or three significant figures would reflect data accuracy better.

[b]Inventory does not include tritium, technetium-99, or iodine-129.

4.0 DISCUSSION OF CHEMICALS RESULTING FROM TANK DISCHARGES TO THE GROUND

While care was taken in the past to measure and control the discharge of the long-lived radionuclides from the SSTs, the same level of controls was not always given to the discharge of chemicals. Chemicals were an integral part of the wastestreams as they were generated. Chemicals such as sodium hydroxide were added to neutralize the waste before it was sent to the SSTs for storage. Chemicals (primarily sodium ferrocyanide) also were added to enhance the precipitation of the long-lived radionuclides before the supernatant was discharged to the ground. The end result was significant quantities of chemicals discharged to the ground as part of the tank waste discharges.

Appendix E provides chemical data for each disposal site that received tank waste discharges. Hanford Site workers developed this data in the mid-1980s as part of the Preliminary Assessment/Site Inspection to support eventual placement on the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) National Priorities Listing (NPL). It is currently contained in the WIDS and is documented in the *Draft Phase I Installation Assessment of Inactive Waste-Disposal Sites at Hanford* (DOE 1986). They calculated the data based on the historical documentation of the processes. The most significant masses shown are for sodium (as a cation) and nitrate (as an anion). This is because of the sodium hydroxide additions for neutralization of the nitrate wastes.

One chemical of concern is the ferrocyanide that was added to the uranium recovery wastestream to precipitate the cesium-137. Some ferrocyanide has been detected in the soil and groundwater; most is in the tanks. One of the higher priority inactive-site investigations is the BY crib complex. This investigation currently is ongoing. A cyanide plume above regulatory standards has moved several miles from the BY cribs.

The chemicals disposed of to the ground will be investigated along with the radionuclides as part of the Hanford Site remedial investigation effort.

5.0 ONGOING ACTIONS AND FUTURE PLANS

Four areas of the Hanford Site were placed on the CERCLA NPL in October 1989. These included the 100, 300, and 1100 Areas along with the 200 Areas which are addressed in this report. In expectation of this, and to achieve compliance with both CERCLA and the *Resource Conservation and Recovery Act of 1976* (RCRA), the Tri-Party Agreement was signed in May 1989. The Tri-Party Agreement lays out the environmental problems according to their risks, sets a schedule for tasks to bring the Hanford Site into compliance, and defines participants' roles and responsibilities.

All disposal sites addressed in this report are included in the Tri-Party Agreement. Final closure of the SSTs, including nearby contaminated soil from leaks, is also covered by the Tri-Party Agreement. All of the disposal sites at the Hanford Site have been grouped into 78 operable units. An operable unit is a grouping of waste sites for the purpose of conducting a remedial investigation and carrying out any remedial actions that may result from the investigation. One of the top priority operable units undergoing remedial investigation is 200-BP-1. This operable unit contains the BY cribs. This is where it was first learned that the cobalt-60 from the scavenged uranium recovery waste supernatant was not held in the soil under the cribs and, therefore, the supernatant had to be sent to specific retention trenches. As a result, the BY cribs present more groundwater contamination problems than some of the other cribs that received tank wastes. All of the other disposal

sites that received tank wastes are in operable units scheduled for investigation in the next few years. The disposal sites that received tank wastes will be investigated and cleaned up as part of the total waste that has been disposed at the Hanford Site.

6.0 REFERENCES

Brown, M. J., R. K. P'Pool, and S. P. Thomas, 1990, *Westinghouse Hanford Company Effluent Discharges and Solid Waste Management Report for Calendar Year 1989: 200/600 Areas*, WHC-EP-0141-2, Westinghouse Hanford Company, Richland, Washington.

Database, Waste Information Data System, as of January 1991.

DOE, 1986, *Draft Phase I Installation Assessment of Inactive Waste - Disposal Sites at Hanford*, Volume II, U.S. Department of Energy, Richland, Washington.

Ecology, EPA, and DOE, 1990, *Hanford Federal Facility Agreement and Consent Order*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and the U.S. Department of Energy, Olympia, Washington.

Hanlon, B. M., 1991, *Tank Farm Surveillance and Waste Status Report for November 1990*, WHC-EP-0182-32, Westinghouse Hanford Company, Richland, Washington.

Haney, W. A. and J. F. Honstead, 1958, *A History and Discussion of Specific Retention Disposal of Radioactive Liquid Wastes in the 200 Areas*, HW-54599.

7.0 BIBLIOGRAPHY

Anderson, J. D., 1990, *A History of the 200 Area Tank Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

Bernard, R. M., 1957, *Radioactive Contamination in Liquid Wastes Discharged to Ground at Separation Facilities through June 1957*, HW-53336.

Bernard, R. M., 1958, *Radioactive Contamination in Liquid Wastes Discharged to Ground at Separation Facilities through December 1957*, HW-55593.

Bernard, R. M., 1958, *Radioactive Contamination in Liquid Wastes Discharged to Ground at Separation Facilities through June 1958*, HW-57649.

DOE, 1987, *Final Environmental Impact Statement, Disposal of Hanford Defense High-Level, Transuranic and Tank Wastes*, DOE/EIS-0113, U.S. Department of Energy, Richland, Washington.

DOE, 1990, *Integrated Data Base for 1990: U.S. Spent Fuel and Radioactive Waste Inventories, Projections, and Calculations*, DOE/RW-0006, Rev. 6, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

ERDA, 1976, *Final Environmental Statement; Waste Management Operations, Hanford Reservation*, ERDA-1538, U.S. Energy Research and Development Administration, Richland, Washington.

Heid, K. R., 1956, *Radioactive Contamination in Liquid Wastes Discharged to Ground at Separation Facilities through June 1956*, HW-44784.

Heid, K. R., 1957, *Radioactive Contamination in Liquid Wastes Discharged to Ground at Separation Facilities through December 1956*, HW-48518.

Maxfield, H. L., 1979, *Handbook--200 Areas Waste Sites*, RHO-CD-673, Rockwell Hanford Operations, Richland, Washington.

Paas, H. J. and K. R. Heid, 1955, *Radioactive Contamination in Liquid Wastes Discharged to Ground at Separation Facilities through June 1955*, HW-38562.

Ruppert, H. G. and K. R. Heid, 1954, *Summary of Liquid Radioactive Wastes Discharged to the Ground--200 Areas July 1952 through June 1954*, HW-33591.

This page intentionally left blank.

APPENDIX A

GLOSSARY

Bismuth phosphate process--a batch process used in T Plant and B Plant to recover plutonium from irradiated fuel during the early years at the Hanford Site.

Cascade--as used with single-shell storage tanks, the process of overflowing waste from one tank to another. A series of two to four (usually three) tanks were used in a cascade overflow system. The waste settled in the preceding tank, and the resultant supernatant overflowed or was pumped through an interconnecting pipeline to the next tank in series. Supernatant wastes were sometimes cascaded to the ground from the last tank in a cascade series.

Crib--an underground structure designed to receive liquid waste, usually through a perforated pipe, or to the soil directly or after traveling to a connected tile field. Cribs used the filtration and ion exchange properties of the soil to contain the radionuclides. A crib was operated until a prescribed radionuclide contamination limit was observed in the groundwater beneath the crib.

First cycle waste--in the early bismuth phosphate plutonium recovery process in T Plant and B Plant, this was the wastestream resulting from the first decontamination cycle following the plutonium separation step. It contained approximately 10 percent of the fission products. This is not the same first-cycle wastestream that results from PUREX process.

Metal waste--in the early bismuth phosphate plutonium recovery process in T Plant and B Plant, this was the extraction waste from the initial plutonium separation step. It contained the uranium and approximately 90 percent of the fission products.

Scavenging (or scavenged waste)--the process of adding chemicals to the radioactive wastestream to remove the long-lived fission products (strontium-90 and cesium-137) as precipitates before discharging the resultant supernatant to the ground.

Second cycle waste--as part of the early plutonium recovery process in T Plant and B Plant, this was the wastestream resulting from the second decontamination cycle. It contained less than 0.1 percent of the fission products. This is not the same second-cycle waste that results from PUREX process.

Specific retention trench--a depression dug in the ground, open to the atmosphere, designed for the disposal of low-level or intermediate- level radioactive wastes. It used the moisture retention capability of the relatively dry soils above the groundwater. Used at the Hanford Site from 1951 to 1958 for tank waste, the volume of liquid waste disposed of to the trench was limited to 6 to 10 percent of the soil volume between the trench and the groundwater so that the liquid would be retained in the soils and not

reach the groundwater table. The trench then was covered up after the prescribed volume of liquids was disposed.

Supernatant--usually refers to the liquid portion of a wastestream after solids have precipitated, usually in a tank.

Tributyl phosphate process--continuous solvent extraction process used in U Plant to recover the uranium from the sluiced and acidified metal waste produced during the early years at the Hanford Site. The metal waste was generated in T Plant and B Plant as part of the bismuth phosphate plutonium recovery process and stored in underground single-shell storage tanks.

APPENDIX B

200 EAST AND WEST AREA MAPS

This page intentionally left blank.

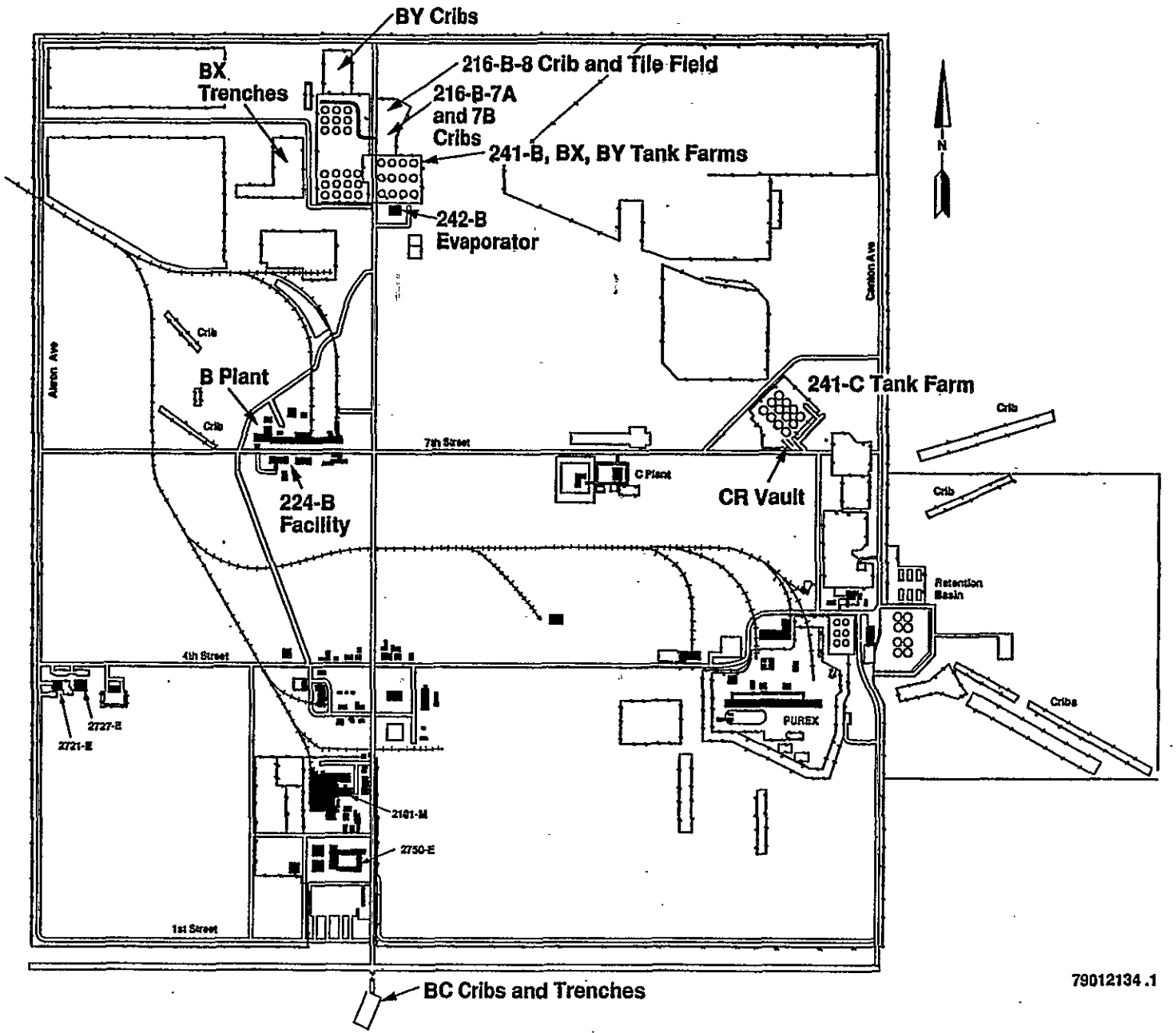
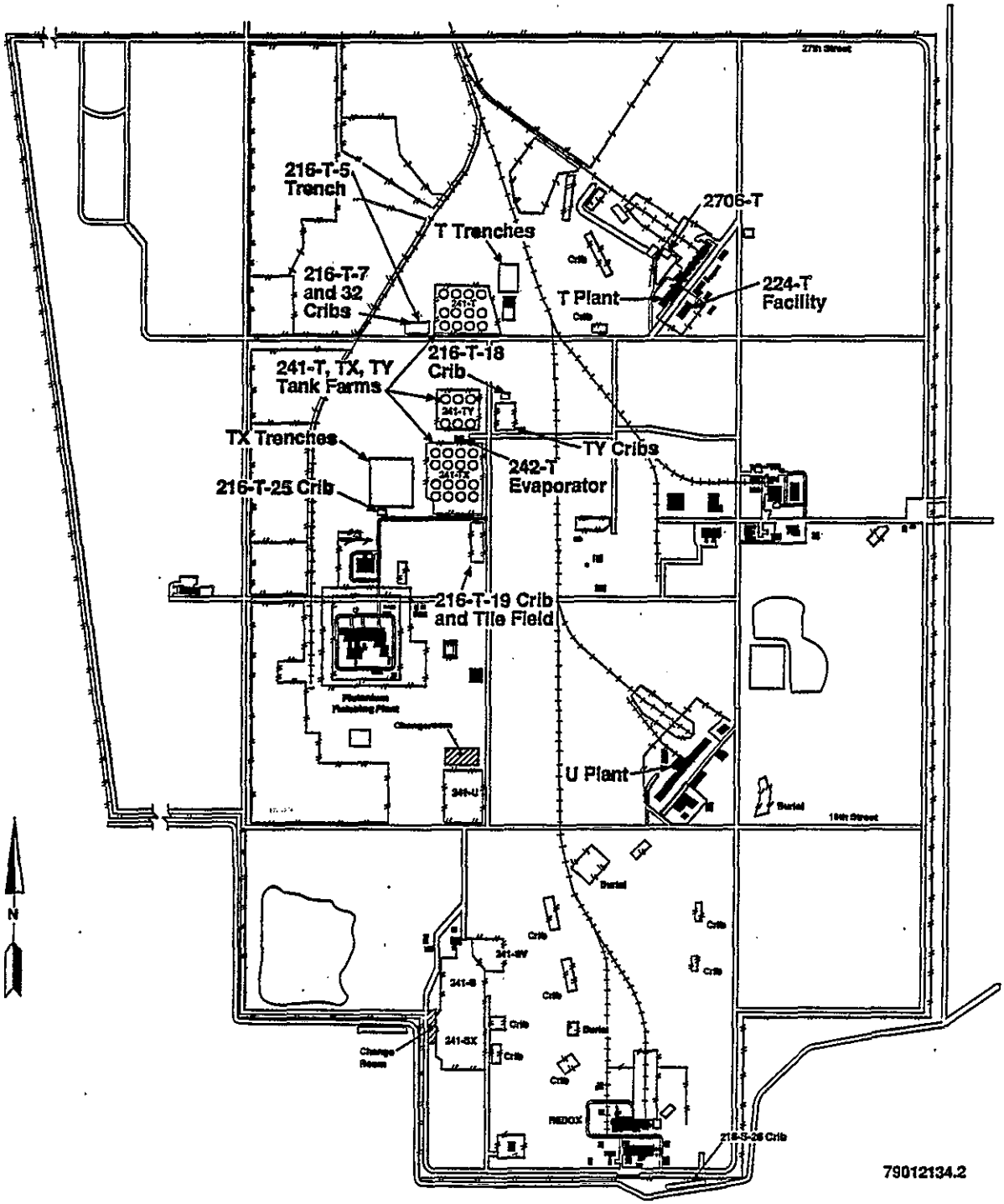


Figure B-1. 200 East Area of the Hanford Site.

This page intentionally left blank.

Figure B-2. 200 West Area of the Hanford Site.



This page intentionally left blank.

APPENDIX C

Table C-1. Discharges by Disposal Site.[a] (sheet 1 of 4)

Disposal site	Years of discharge	Volume discharged in thousands of liters (gallons)	Waste type
200 EAST AREA:			
216-B-7A&B cribs	1946-1953	42,900 (11,334)	224-B facility wastes
216-B-8 crib and tile field	1948-1953	27,200 (7,186)	Second-cycle supernatant from B Plant; tank 5-6 wastes from B Plant
BC cribs and trenches			
216-B-14 crib	1956	8,710 (2,301)	Scavanged uranium recovery waste from U Plant
216-B-15 crib	1956-1957	6,320 (1,670)	Scavanged uranium recovery waste from U Plant
216-B-16 crib	1956	5,600 (1,479)	Scavanged uranium recovery waste from U Plant
216-B-17 crib	1956	3,410 (901)	Scavanged uranium recovery waste from U Plant
216-B-18 crib	1956	8,520 (2,251)	Scavanged uranium recovery waste from U Plant
216-B-19 crib	1957	6,400 (1,691)	Scavanged uranium recovery waste from U Plant
216-B-20 trench	1956	4,680 (1,236)	Scavanged uranium recovery waste from U Plant
216-B-21 trench	1956	4,670 (1,234)	Scavanged uranium recovery waste from U Plant
216-B-22 trench	1956	4,740 (1,252)	Scavanged uranium recovery waste from U Plant
216-B-23 trench	1956	4,520 (1,194)	Scavanged uranium recovery waste from U Plant
216-B-24 trench	1956	4,700 (1,242)	Scavanged uranium recovery waste from U Plant
216-B-25 trench	1956	3,760 (993)	Scavanged uranium recovery waste from U Plant

[a]Numbers reflect data in the database and were used so they could be traced. They reflect greater accuracy than warranted by the number of figures shown. Two or three significant figures would reflect data accuracy better.

Table C-1. Discharges by Disposal Site.[a] (sheet 2 of 4)

Disposal site	Years of discharge	Volume discharged in thousands of liters (gallons)	Waste type
216-B-26 trench	1956-1957	5,880 (1,553)	Scavanged uranium recovery waste from U Plant
216-B-27 trench	1957	4,420 (1,168)	Scavanged uranium recovery waste from U Plant
216-B-28 trench	1957	5,050 (1,334)	Scavanged uranium recovery waste from U Plant
216-B-29 trench	1957	4,840 (1,279)	Scavanged uranium recovery waste from U Plant
216-B-30 trench	1957	4,780 (1,263)	Scavanged uranium recovery waste from U Plant
216-B-31 trench	1957	4,740 (1,252)	Scavanged uranium recovery waste from U Plant
216-B-32 trench	1957	4,770 (1,260)	Scavanged uranium recovery waste from U Plant
216-B-33 trench	1957	4,740 (1,252)	Scavanged uranium recovery waste from U Plant
216-B-34 trench	1957	4,870 (1,287)	Scavanged uranium recovery waste from U Plant
216-B-52 trench	1957-1958	8,530 (2,254)	Scavanged uranium recovery waste from U Plant
		BX trenches	
216-B-35 trench	1954	1,060 (280)	First-cycle supernatant from B Plant
216-B-36 trench	1954	1,940 (513)	First-cycle supernatant from B Plant
216-B-37 trench	1954	4,320 (1,141)	Evaporator bottoms from 242-B evaporator
216-B-38 trench	1954	1,430 (378)	First-cycle supernatant from B Plant
216-B-39 trench	1953-1954	1,540 (407)	First-cycle supernatant from B Plant
216-B-40 trench	1954	1,640 (433)	First-cycle supernatant from B Plant

[a] Numbers reflect data in the database and were used so they could be traced. They reflect greater accuracy than warranted by the number of figures shown. Two or three significant figures would reflect data accuracy better.

Table C-1. Discharges by Disposal Site.[a] (sheet 3 of 4)

Disposal site	Years of discharge	Volume discharged in thousands of liters (gallons)	Waste type
216-B-41 trench	1954	1,440 (380)	First-cycle supernatant from B Plant
216-B-42 trench	1955	1,500 (396)	Scavanged uranium recovery waste from U Plant
		BY cribs	
216-B-43 crib	1954	2,120 (560)	Scavenged uranium recovery waste from U Plant
216-B-44 crib	1954-1955	5,600 (1,479)	Scavenged uranium recovery waste from U Plant
216-B-45 crib	1955	4,920 (1,300)	Scavenged uranium recovery waste from U Plant
216-B-46 crib	1955	6,700 (1,770)	Scavenged uranium recovery waste from U Plant
216-B-47 crib	1955	3,710 (980)	Scavenged uranium recovery waste from U Plant
216-B-48 crib	1955	4,090 (1,081)	Scavenged uranium recovery waste from U Plant
216-B-49 crib	1955	6,700 (1,770)	Scavenged uranium recovery waste from U Plant
		200 WEST AREA:	
216-T-5 trench	1955	2,600 (687)	Second-cycle supernatant from T Plant
216-T-7 crib	1948-1955	110,000 (29,061)	Second-cycle supernatant from T Plant; 224-T facility wastes; tank 5-6 wastes from T Plant
		T trenches	
216-T-14 trench	1954	1,000 (264)	First-cycle supernatant from T Plant
216-T-15 trench	1954	1,000 (264)	First-cycle supernatant from T Plant
216-T-16 trench	1954	1,000 (264)	First-cycle supernatant from T Plant

[a]Numbers reflect data in the database and were used so they could be traced. They reflect greater accuracy than warranted by the number of figures shown. Two or three significant figures would reflect data accuracy better.

Table C-1. Discharges by Disposal Site.[a] (sheet 4 of 4)

Disposal site	Years of discharge	Volume discharged in thousands of liters (gallons)	Waste type
216-T-17 trench	1954	785 (207)	First-cycle supernatant from T Plant
216-T-18 crib	1953	1,000 (264)	Scavenged uranium recovery waste from U Plant
216-T-19 crib and tile field	1955-1956	10,580 (2,795)	Second-cycle supernatant from T Plant; 224-T facility wastes; tank 5-6 wastes from T Plant
		TX trenches	
216-T-21 trench	1954	460 (122)	First-cycle supernatant from T Plant
216-T-22 trench	1954	1,530 (404)	First-cycle supernatant from T Plant
216-T-23 trench	1954	1,480 (391)	First-cycle supernatant from T Plant
216-T-24 trench	1954	1,530 (404)	First-cycle supernatant from T Plant
216-T-25 trench	1954	3,000 (793)	Evaporator bottoms from 242-T evaporator
		TY cribs	
216-T-26 crib	1955-1956	12,000 (3,170)	Scavenged first-cycle supernatant from T Plant
216-T-28 crib	1960-1966	42,300 (11,175)	Steam condensate, decontamination wastes, and miscellaneous effluents from T Plant; 2706-T facility decontamination wastes; 340 facility laboratory wastes
216-T-32 crib	1946-1952	29,000 (7,662)	224-T facility wastes
TOTAL DISCHARGE		456,725 (120,661)	

[a]Numbers reflect data in the database and were used so they could be traced. They reflect greater accuracy than warranted by the number of figures shown. Two or three significant figures would reflect data accuracy better.

APPENDIX D

Table D-1. Radionuclide Data by Disposal Site.
(sheet 1 of 3)

Disposal site	^{90}Sr (Ci)	^{137}Cs (Ci)	Plutonium (g)	Total curies[a]
		Cribs		
216-B-7	2,200	43	1,720	4,646
216-B-8	6	20	30	53
216-B-14	172	114	25	568
216-B-15	87	92	5	355
216-B-16	302	296	10	1,181
216-B-17	69	100	10	333
216-B-18	82	114	10	386
216-B-19	88	126	10	423
216-B-43	574	130	1	1,401
216-B-44	1,200	309	15	3,003
216-B-45	1,180	666	10	3,657
216-B-46	631	89	20	1,437
216-B-47	261	67	5	652
216-B-48	547	200	5	1,484
216-B-49	1,140	182	15	2,636
216-T-7	24	21	130	102
216-T-18	3	242	1,808	223
216-T-19	28	175	14	397
216-T-26	282	76	59	717
216-T-28	106	193	70	594
216-T-32	11	10	3,192	342
Subtotal	8,992	3,047	7,164	24,589

[a]Inventory does not include tritium, technetium-99, or iodine-129. Inventory does include daughter products and other radionuclides not shown here.

Table D-1. Radionuclide Data by Disposal Site.
(sheet 2 of 3)

Disposal site	^{90}Sr (Ci)	^{137}Cs (Ci)	Plutonium (g)	Total curies
	Specific retention trenches			
216-B-20	340	684	1	2,011
216-B-21	318	169	10	966
216-B-22	176	21	3	392
216-B-23	63	51	2	224
216-B-24	78	59	8	271
216-B-25	88	26	2	226
216-B-26	475	438	2	1,803
216-B-27	263	16	1	557
216-B-28	50	11	6	120
216-B-29	85	27	1	223
216-B-30	265	1,570	2	3,585
216-B-31	92	13	5	210
216-B-32	113	59	3	340
216-B-33	18	127	12	284
216-B-34	18	8	6	52
216-B-52	5	160	19	323
216-B-35	96	185	1	553
216-B-36	199	336	1	1,052
216-B-37	7	1,350	2	2,640
216-B-38	759	221	1	1,948
216-B-39	9	192	2	392
216-B-40	115	153	1	528
216-B-41	19	386	0	790
216-B-42	463	43	10	1,010
216-T-5	0	31	181	78
216-T-14	2	204	1	402
216-T-15	9	450	1	893
216-T-16	3	227	1	448

[a]Inventory does not include tritium, technetium-99, or iodine-129. Inventory does include daughter products and other radionuclides not shown here.

Table D-1. Radionuclide Data by Disposal Site.
(sheet 3 of 3)

Disposal site	^{90}Sr (Ci)	^{137}Cs (Ci)	Plutonium (g)	Total curies
Specific retention trenches (continued)				
216-T-17	1	162	1	318
216-T-21	3	174	1	345
216-T-22	21	803	2	1,605
216-T-23	17	577	1	1,157
216-T-24	16	617	2	1,234
216-T-25	2	3,860	1	7,515
Subtotal	4,189	13,408	291	34,496
TOTAL	13,181	16,455	7,455	59,085

[a]Inventory does not include tritium, technetium-99, or iodine-129. Inventory does include daughter products and other radionuclides not shown here.

This page intentionally left blank.

APPENDIX E

ESTIMATED CHEMICAL DATA BY DISPOSAL SITE

Table E-1. Estimated Chemical Data by Disposal Site (in kilograms). (sheet 1 of 3)

Disposal site	Fluoride (F^-)	Ferro-cyanide	Sodium (Na^+)	Sodium aluminate	Sodium oxalate	Sodium silicate	Ammonium nitrate	Nitrate (NO_2^{-1})	Nitrate (NO_3^{-1})	Phosphate (PO_4^{-3})	Sulfate (SO_4^{-2})
						Cribs					
216-B-7A&B	240,000		1,600,000				22,000		1,800,000	130,000	15,000
216-B-8TF			900,000				160,000		1,400,000	500,000	70,000
216-B-14		5,000	600,000						1,500,000	40,000	50,000
216-B-15		3,300	400,000						900,000	50,000	60,000
216-B-16		3,000	500,000						1,100,000	70,000	110,000
216-B-17		1,800	500,000						1,100,000	60,000	90,000
216-B-18		5,000	400,000						1,000,000	50,000	70,000
216-B-19		3,400	700,000						1,500,000	100,000	90,000
216-B-43		1,100	170,000						400,000	21,000	29,000
216-B-44		3,000	330,000						800,000	40,000	60,000
216-B-45		2,600	340,000						90,000	41,000	60,000
216-B-46		4,000	500,000						1,200,000	70,000	100,000
216-B-47		2,000	310,000						700,000	40,000	60,000
216-B-48		2,200	400,000						1,000,000	60,000	80,000
216-B-49		4,000	600,000						1,500,000	60,000	80,000
216-T-7TF	170,000		1,700,000		40,000		140,000		300,000	500,000	70,000
216-T-18	2,500		60,000	8,000		3,200			80,000	19,000	4,000
216-T-19TF			90,000						150,000	60,000	9,000
216-T-26	30,000	6,000	700,000	100,000		40,000			1,000,000	230,000	50,000
216-T-28									10,000		
216-T-32	160,000		1,100,000		40,000				1,200,000	90,000	10,000
Subtotal	627,500	46,400	11,900,000	108,000	80,000	43,200			20,730,000	2,231,000	1,167,000

NOTES: All chemicals were in a combined or ionic form when discharged to the ground. The exact form in the ground is not known. The quantity calculations are based on process knowledge and volumes of liquid discharged. Many other chemicals also are in liquids discharged to ground.

Table E-1. Estimated Chemical Data by Disposal Site (in kilograms). (sheet 2 of 3)

Disposal site	Fluoride (F^-)	Ferro-cyanide	Sodium (Na^+)	Sodium aluminate	Sodium oxalate	Sodium silicate	Ammonium nitrate	Nitrate (NO_2^{-1})	Nitrate (NO_3^{-1})	Phosphate (PO_4^{-3})	Sulfate (SO_4^{-2})
Specific retention trenches											
216-B-21		2,500	310,000						700,000	40,000	60,000
216-B-22		2,500	400,000						900,000	40,000	80,000
216-B-23		2,400	400,000						1,000,000	60,000	60,000
216-B-24		2,500	280,000						600,000	34,000	50,000
216-B-25		2,000	220,000						500,000	27,000	40,000
216-B-26		3,100	350,000						800,000	40,000	60,000
216-B-27		2,300	260,000						600,000	32,000	50,000
216-B-28		2,700	400,000						1,000,000	50,000	80,000
216-B-29		2,600	280,000						700,000	35,000	50,000
216-B-30		2,500	500,000						1,100,000	70,000	110,000
216-B-31		2,500	500,000						1,100,000	60,000	90,000
216-B-32		2,500	500,000						1,000,000	60,000	90,000
216-B-33		2,500	700,000						1,700,000	100,000	110,000
216-B-34		2,600	800,000						1,900,000	80,000	90,000
216-B-35	2,600		60,000	10,000		5,500		10,000	90,000	20,000	4,000
216-B-36	5,000		120,000	24,000		10,000		18,000	160,000	40,000	8,000
216-B-37	50,000		1,300,000	250,000		5,500		200,000	1,700,000	400,000	90,000
216-B-38	4,000		90,000	18,000		10,000		13,000	120,000	27,000	6,000
216-B-39	4,000		90,000	18,000		100,000		14,000	120,000	29,000	6,000
216-B-40	4,000		100,000	20,000		8,000		15,000	130,000	31,000	7,000
216-B-41	4,000		90,000	18,000		8,000		13,000	120,000	27,000	6,000
216-B-42		800	90,000			8,000			210,000	11,000	15,000

NOTES: All chemicals were in a combined or ionic form when discharged to the ground. The exact form in the ground is not known. The quantity calculations are based on process knowledge and volumes of liquid discharged. Many other chemicals also are in liquids discharged to ground.

Table E-1. Estimated Chemical Data by Disposal Site (in kilograms). (sheet 3 of 3)

Disposal site	Fluoride (F^-)	Ferro-cyanide	Sodium (Na^+)	Sodium aluminate	Sodium oxalate	Sodium silicate	Ammonium nitrate	Nitrate (NO_2^{-1})	Nitrate (NO_3^{-1})	Phosphate (PO_4^{-3})	Sulfate (SO_4^{-2})
Specific retention trenches											
216-B-52		5,000	860,000		1,000	8,000			2,100,000	80,000	80,000
216-T-5	8,000		100,000			8,000	20,000		140,000	60,000	9,000
216-T-14	2,500		60,000	8,000		3,200		9,000	80,000	19,000	4,000
216-T-15	2,500		60,000	8,000		3,200		9,000	80,000	19,000	4,000
216-T-16	2,500		60,000	8,000		3,200		9,000	80,000	19,000	4,000
216-T-17	2,000		50,000	7,000		2,500		7,000	60,000	15,000	3,100
216-T-21	1,200		28,000	4,000		1,500		4,000	40,000	9,000	1,800
216-T-22	4,000		90,000	13,000		5,000		14,000	120,000	29,000	6,000
216-T-23	4,000		90,000	12,000		5,000		14,000	120,000	28,000	6,000
216-T-24	4,000		90,000	13,000		5,000		14,000	120,000	29,000	6,000
216-T-25	40,000		900,000	130,000		50,000		140,000	1,200,000	290,000	60,000
Subtotal	144,300	43,500	10,728,080	561,000	1,000	234,100	20,000	503,000	21,490,000	1,900,000	1,445,900
TOTAL	771,800	89,900	22,628,000	669,000	81,000	277,300	376,000	622,000	242,220,000	4,131,000	2,612,900

NOTES: All chemicals were in a combined or ionic form when discharged to the ground. The exact form in the ground is not known. The quantity calculations are based on process knowledge and volumes of liquid discharged. Many other chemicals also are in liquids discharged to ground.

DISTRIBUTION

Number of Copies

OFFSITE

6 U.S. Department of Energy-Headquarters
Washington, D.C.

S. P. Cowan EM-33 Germantown
C. G. Halsted DP-13 Germantown
J. C. Lehr EM-442 Germantown
J. E. Lytle EM-30 Forrestal
K. I. Taimi EH-22 Forrestal
J. C. Tseng EH-20 Forrestal

4 U.S. Environmental Protection Agency

C. E. Findley, Director
Hazardous Waste Division
(M/C HW-111)
1200 Sixth Avenue
Seattle, WA 98101

G. Hofer
1200 Sixth Avenue
Seattle, WA 98101

D. Rasmussen
Administrator
1200 Sixth Avenue
Seattle, WA 98101

R. F. Smith
1200 Sixth Avenue
Seattle, WA 98101

1 Yakima Tribal Council

Levi George
P.O. Box 151 (Fort Road)
Toppenish, WA 98948

Number of Copies

OFFSITE

1 Confederated Tribes of the Umatilla Indian Reservation

Elwood Patawa
P.O. Box 638
Pendleton, OR 97801

1 Nez Perce Tribal Executive Council

C. H. Hayes, Chairman
P.O. Box 305
Lapwai, ID 83540

1 State of Oregon Department of Energy

D. Stewart-Smith
625 Marion Street N.E.
Salem, OR 97310

5 Washington State Department of Ecology
5826 Pacific Avenue
Lacey, WA 98503

J. Breckel
C. Gregoire
T. Hussman
T. Nord
R. Stanley

40 Nuclear Waste Advisory Council

K. Iyal
State of Washington
Department of Ecology
Mail Stop PV-11
Olympia, WA 98504

1 Sierra Club Northwest Office
1516 Melrose Avenue
Seattle, WA 98122

DISTRIBUTION (Cont)

Number of Copies

OFFSITE

1 Ruth F. Wiener
Western Washington University
Bellingham, WA 98225

1 Senator Brock Adams
#2988 Jackson Federal Office Building
915 2nd Avenue
Seattle, WA 98714

1 Charlotte Denniston
Greenpeace
11815 - 20th S.W.
Seattle, WA 98146

1 John Lindsay, President
Tri-City Industrial Development Council
901 N. Colorado
Kennewick, WA 99336

1 Diana Bradshaw
Audubon Society of Portland
5151 Northwest Cornell Road
Portland, OR 97210

1 Jim Thomas
Hanford Education Action League
1720 N. Ash
Spokane, WA 99205

1 David W. Stevens
Environmental Assurance Inc.
203 East 4th Avenue
Suite 422
Olympia, WA 98501

Number of Copies

OFFSITE

1 Physicians for Social Responsibility
4534 1/2 University Way N.E.
Seattle, WA 98105

1 Charles W. F. Bell, Staff Director
Oregon Fellowship for Reconciliation
1838 S.W. Jefferson
Portland, OR 97201

1 Richard Belsey, M.D.
Oregon Health Sciences University
Department of Clinical Pathology L471
3181 S.W. Sam Jackson Park Road
Portland, OR 97201

1 Steve Binney
Radiation Center, A100
Oregon State University
Corvallis, OR 97331-5903

1 Norm Buske
Search Technical Services
Star Route Box 17
Davenport, WA 99112

1 Russ Keven Childers
223 14th E. #201
Seattle, WA 98112

1 F. R. Cook
2552 Harris Avenue
Richland, WA 99352

DISTRIBUTION (Cont)

Number of Copies

OFFSITE

1 Cindy De Bruler
Columbia River United
P.O. Box 667
Bingen, WA 98605

1 Cathy Kirkham
Greenpeace
4649 Sunnyside Avenue
Seattle, WA 98103

1 Victor Lacourse
437 N.E. Fargo
Portland, OR 97212

1 Lloyd K. Marbet
Forelaws on Board
19142 S. Bakers Ferry Road
Boring, OR 97009

1 James Monteith
Oregon Natural Resources Council
1161 Lincoln Street
Eugene, OR 97401

1 Martha Odom
333 S.E. 3rd
Portland, OR 97214

1 Joanne Oleksiak, Director
Hanford Clearinghouse
2829 S.E. Belmont #308
Portland, OR 97214

1 Leonard Palmer
Portland State University
P.O. Box 751
Portland, OR 97207

1 Ray Paris
Oregon State Health Division
State Office Building
Portland, OR 97204

Number of Copies

OFFSITE

1 Ralph Patt
Water Resources Department
555 13th Street, N.E.
Salem, OR 97301

1 Gerald Pollet, Exec. Direc.
Heart of America Northwest
1305 4th Avenue #208
Seattle, WA 98101

1 Norma Jean Germond
League of Women Voters
224 Iron Mountain Boulevard
Lake Oswego, OR 97034

1 Don Reicher
Natural Resources Defense Council
1350 New York Avenue N.W.
Suite 300
Washington, D.C. 20005

1 Bill Mitchell
Nuclear Safety Campaign
1914 North 34th Street #407
Seattle, WA 98103

1 Sharon Kophs
Westinghouse
North 221 Wall Street
Suite 446
Spokane, WA 99201

1 The Honarable Sid Morrison
House Office Building
1434 Longworth
Washington, D.C. 20575

1 J. T. Stewart
U.S. Army Corps of Engineers
Walla Walla District
Walla Walla, WA 99362-9265

DISTRIBUTION (Cont)

Number of Copies

OFFSITE

1 Kristine Gebbie
Department of Health
1300 Quince
Olympia, WA 98504

1 Ms. Sandi Strawn, Chair
Benton County Board of Commissioners
P.O. Box 190
Prosser, WA 99350-0190

1 Lane Bray
Washington State House of Representatives
John L. O'Brien Building
Room 303
Olympia, WA 98504

1 Curtis Ludwig
Wasington State House of Representatives
John L. O'Brien Building
Room 304
Olympia, WA 98504

ONSITE

4 U.S. Environmental Protection Agency
P. Day B5-01

1 Hanford Environmental Health Foundation
L. J. Maas B2-75

1 Kaiser Engineers Hanford
W. H. Bodily E3-33

Number of Copies

ONSITE

5 Pacific Northwest Laboratory

W. J. Bjorklund	P7-68
W. F. Bonner	P7-44
T. D. Chikalla	P7-75
M. S. Hanson	K1-51
W. R. Wiley	K1-46

27 U.S. Department of Energy-Richland Operations Office

J. H. Anttonen	A5-10
T. A. Bauman	A7-75
W. W. Bixby	A7-50
G. J. Bracken	R4-04
K. W. Bracken	A5-22
R. D. Freeberg	A5-19
J. D. Furubotten	A5-18
R. E. Gerton	A5-21
E. S. Goldberg	A7-50
J. P. Hamric	A6-56
N. M. Highland	A7-27
R. A. Holten	A5-55
J. R. Hunter	A6-53
R. D. Izatt	A5-19
A. W. Kellogg	A7-80
R. D. Larson	A7-80
R. J. Light	A7-88
L. E. Little	A5-22
J. E. Mecca	A6-55
R. J. Nevarez	A5-21
W. A. Rutherford	A5-21
R. P. Saget	A5-52
J. J. Sutey	A5-90
J. D. Wagoner	A7-50
L. C. Williams	A5-18
S. H. Wisness	A5-19
Reading Room	A1-65

DISTRIBUTION (Cont)

Number of Copies

ONSITE

84 Westinghouse Hanford Company

M. R. Adams	H4-55	R. J. Roberts	N3-13
T. M. Anderson	B3-01	J. H. Roecker	R2-28
B. A. Austin	B2-14	W. G. Ruff	R2-53
H. Babad	H4-23	J. P. Schmidt	X0-41
T. B. Bergman	B2-35	D. E. Simpson	B3-09
M. V. Berriochoa	B3-30	J. O. Skolrud	B2-20
R. J. Bliss	B3-04	R. G. Slocum	B5-21
G. L. Borsheim	R2-11	R. A. Smith	G6-02
S. L. Brey	T6-12	D. A. Turner	R1-48
L. C. Brown	H4-51	T. B. Veneziano	B2-35
M. C. Brown	B2-20	E. P. Vodney	B3-50
J. G. Burk	B3-25	J. L. Waite	B2-35
G. D. Carpenter	B2-16	D. J. Washenfelder	S6-18
J. G. Cassady	B3-07	D. D. Wodrich	R2-23
C. DeFigh-Price	H4-23	R. D. Wojtasek	L4-92
J. L. Deichman	H4-23	D. E. Wood	B2-19
R. R. Disibio	B3-02	J. A. Yount	L0-18
W. T. Dixon	B2-35	Central Files	L8-15
B. P. Dole	A2-50	EDMC (20)	H4-22
C. Edwards	B3-35	Publication Services (3)	L8-07
B. G. Erlandson	B2-19	Hanford Technical Library	P8-55
M. R. Fox	B2-35	Tank Farm Information Center (TFIC)	R1-28
R. D. Fox	H4-52		
C. J. Geier	H4-57		
M. S. Gerber	H4-55		
P. S. Hale	B3-35		
C. Haller	L6-29		
H. D. Harmon	R2-52		
M. E. Harris	B3-35		
V. W. Hall	L4-88		
W. F. Heine	B2-35		
K. L. Hoewing	B3-06		
J. O. Honeyman	A4-25		
G. W. Jackson	R4-01		
K. R. Jordan	B3-51		
J. R. Knight	B4-52		
M. K. Korenko	B3-08		
R. E. Lerch	B2-35		
H. E. McGuire	B2-35		
G. A. Meyer	R2-28		
L. L. Powers	B2-35		
R. E. Raymond	R1-80		

DISTRIBUTION (Cont)

Number of Copies

ONSITE

84 Westinghouse Hanford Company

M. R. Adams	H4-55	R. J. Roberts	N3-13
T. M. Anderson	B3-01	J. H. Roecker	R2-28
B. A. Austin	B2-14	W. G. Ruff	R2-53
H. Babad	H4-23	J. P. Schmidt	X0-41
T. B. Bergman	B2-35	D. E. Simpson	B3-09
M. V. Berriochoa	B3-30	J. O. Skolrud	B2-20
R. J. Bliss	B3-04	R. G. Slocum	B5-21
G. L. Borsheim	R2-11	R. A. Smith	G6-02
S. L. Brey	T6-12	D. A. Turner	R1-48
L. C. Brown	H4-51	T. B. Veneziano	B2-35
M. C. Brown	B2-20	E. P. Vodney	B3-50
J. G. Burk	B3-25	J. L. Waite	B2-35
G. D. Carpenter	B2-16	D. J. Washenfelder	S6-18
J. G. Cassady	B3-07	D. D. Wodrich	R2-23
C. DeFigh-Price	H4-23	R. D. Wojtasek	L4-92
J. L. Deichman	H4-23	D. E. Wood	B2-19
R. R. Disibio	B3-02	J. A. Yount	L0-18
W. T. Dixon	B2-35	Central Files	L8-15
B. P. Dole	A2-50	EDMC (20)	H4-22
C. Edwards	B3-35	Publication Services (3)	L8-07
B. G. Erlandson	B2-19	Hanford Technical Library	P8-55
M. R. Fox	B2-35	Tank Farm Information Center (TFIC)	R1-28
R. D. Fox	H4-52		
C. J. Geier	H4-57		
M. S. Gerber	H4-55		
P. S. Hale	B3-35		
C. Haller	L6-29		
H. D. Harmon	R2-52		
M. E. Harris	B3-35		
V. W. Hall	L4-88		
W. F. Heine	B2-35		
K. L. Hoewing	B3-06		
J. O. Honeyman	A4-25		
G. W. Jackson	R4-01		
K. R. Jordan	B3-51		
J. R. Knight	B4-52		
M. K. Korenko	B3-08		
R. E. Lerch	B2-35		
H. E. McGuire	B2-35		
G. A. Meyer	R2-28		
L. L. Powers	B2-35		
R. E. Raymond	R1-80		